TEMPORAL ACTIVITY PATTERNS OF A *DIPODOMYS ORDII* POPULATION

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Abstract.— Temporal activity patterns for *Dipodomys ordii* were generally bimodal during the summer, with the highest peak occurring during early predawn hours when conditions were optimum for water conservation. Removal of dominant members in the population resulted in a substantial shift in the activity pattern to increased activity during the evening hours.

Ecologists studying small mammals must continually attempt to resolve the problems of inadequate methods to study daily activity patterns in natural environments, especially when studying secretive and/or nocturnal species that require trapping procedures. Usefulness of temporal activity data has been demonstrated in simulation trapping studies (Burnham and Overton 1969, Manly 1970, Jorgensen et al. 1972), population estimator studies (Scott et al. 1978), and energetics studies (Kenagy 1973), among others. Although methods for obtaining data under field conditions have not been well developed, some have been reported (Jorgensen and Hayward 1965, Bider 1968, Marten 1973). Generally, their results are deficient in one or more of the following: (1) numbers of recorded activity events per day, (2) timing of the observed or measured activity event, (3) ability to assign an activity event to a specific individual, and (4) correlation between the measured activity under laboratory conditions with analogous activity in natural environments.

Harling (1971) attempted to relieve some of the difficulty in recording activity by developing a trap that could be continually monitored during a trapping period. His traps were electrically wired to a central communications console. Using walkie-talkie communications between someone on the grid and another at the console, Harling (1971) was able to obtain the precise time when an animal was caught as well as when it was released.

We extended Harling's (1971) methods to include an entire grid of traps comparably wired (Garcia et al. 1974) to study a population of *Dipodomys ordii* under field conditions. Our objectives were to determine the optimum foraging times for *D. ordii* in the salt desert shrub community of west-central Utah, and illustrate activity patterns that could assist in interpreting trapping data from other studies that include this species.

Study Site and Methods

Data were collected from two sites at the Desert Range Experiment Station, Millard Co., Utah, from 21 August to 3 September 1971 and 25 June to 27 August 1973. Although *D. ordii* was the species trapped most frequently during this study, *Perognathus longimembris* was common and *Peromyscus maniculatus* and *Onychomys leucogaster* were trapped occasionally. Both sites were sandy and dominated by *Oryzopsis hymenoides*, *Chrysothamnus nauseosus*, and *Salsola kali*, although *Ambrosia acanthicarpa*, *Astragalus* spp., *Atriplex canescens*, *Gilia hutchinsifolia*, and *Hilaria jamesii* also were present.

The trap design and surveillance methods were described in detail by Garcia et al. (1974). A 10 X 10 (100 traps) grid was wired to a central communications console, where one researcher recorded traps as they were "set off." He then informed an assistant working on the grid where trapped animals were. Animal data were radioed from the assistant to the researcher at the console by walkie-talkie. Data were then recorded and the trap reset. Animals seldom were detained in traps for more than a few minutes. Data collected in our study included: species, relative age (juvenile, subadult, adult), sex, repro-

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ductive condition, and identification mark (toe clip). Supportive data, used as the independent variables in our analyses and collected each time an animal was captured, were: ambient temperature, soil temperature, wind speed, cloud cover and lunar events (subjectively assessed), light intensity, barometric pressure, and relative humidity. Absolute humidities (gm/m^3) were determined using the methods described by Platt and Griffiths (1964), i.e., $x = 217(\mathrm{RH})\ (e_s)/100\mathrm{T}$, where T is degrees Kelvin and e_s is vapor pressures in air saturated with water.

The period between sundown and sunrise was divided into 20 subperiods, which were used as the time units while plotting activity. Since activity periods changed slightly as day lengths changed, it was necessary to establish a standard set of subperiods before data for different periods could be pooled. Stepwise regression methods were used to assess the effects of independent variables on activity rates among the pooled data for all activity subperiods. Differences in activity among sexes, ages, and reproductive condition classes were determined using Chi-square tests of independence.

An opportunity to assess possible effects of socially dominant individuals in the *D. ordii* population was noted after three weeks of activity data had been gathered in 1973. An animal was considered dominant if it was the only adult captured within the area prescribed when its capture points had been connected, or if it was the only adult repeatedly caught in a specific trap. Eleven dominant individuals among the 42 individuals recorded on the grid were removed from the poulation and activity data gathered for an additional five days. Temporal activity patterns of the populations before and after the selected removals were compared.

RESULTS AND DISCUSSION

Activity for the intact population of *D. ordii* was essentially bimodal, with the greatest activity occurring during the predawn hours

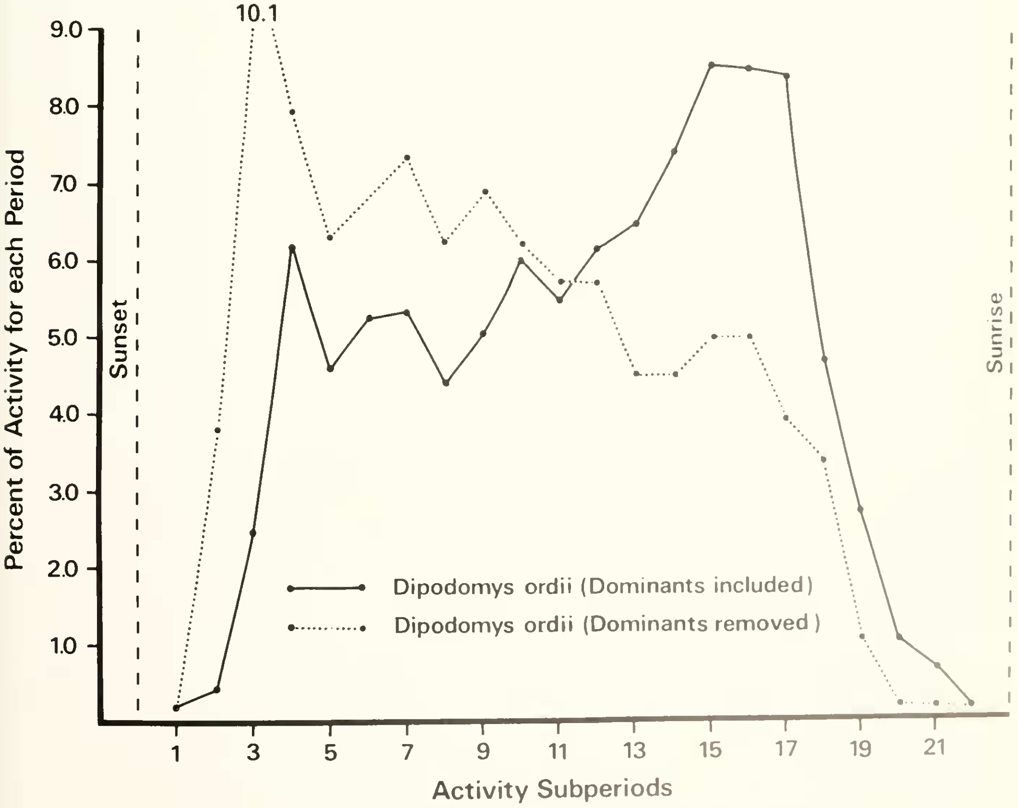

Fig. 1. Activity patterns for *Dipodomys ordii* pooled among 20 subperiods over a 24-hour activity period

(Fig. 1). These observations agree with Jorgensen and Hayward (1965), although our early evening peak is not as distinct. Since their data were gathered over the entire year from trapping rates per hour, we question whether their results are directly comparable with ours. Although we have no season-specific data to demonstrate seasonal variations in activity patterns, any variation would produce composite patterns difficult to interpret and compare.

Precipitation (11.4 cm) was unusually low in 1971 and rather high (20.5 cm) in 1973. These differences in moisture were accompanied by comparable differences in vegetative production—low in 1971 and high in 1973 (Jorgensen, unpublished data). Chi-square analyses resulted in only 6 of a possible 20 tests being significant (p = .95). All the 6 cohorts of animal classes that were significant included adults (Table 1). The observations suggest that adults are more sensitive to seasonal changes in precipitation and vegetative production than immature classes (Fig. 2). The apparent difference was a change from reduced activity of fewer adults

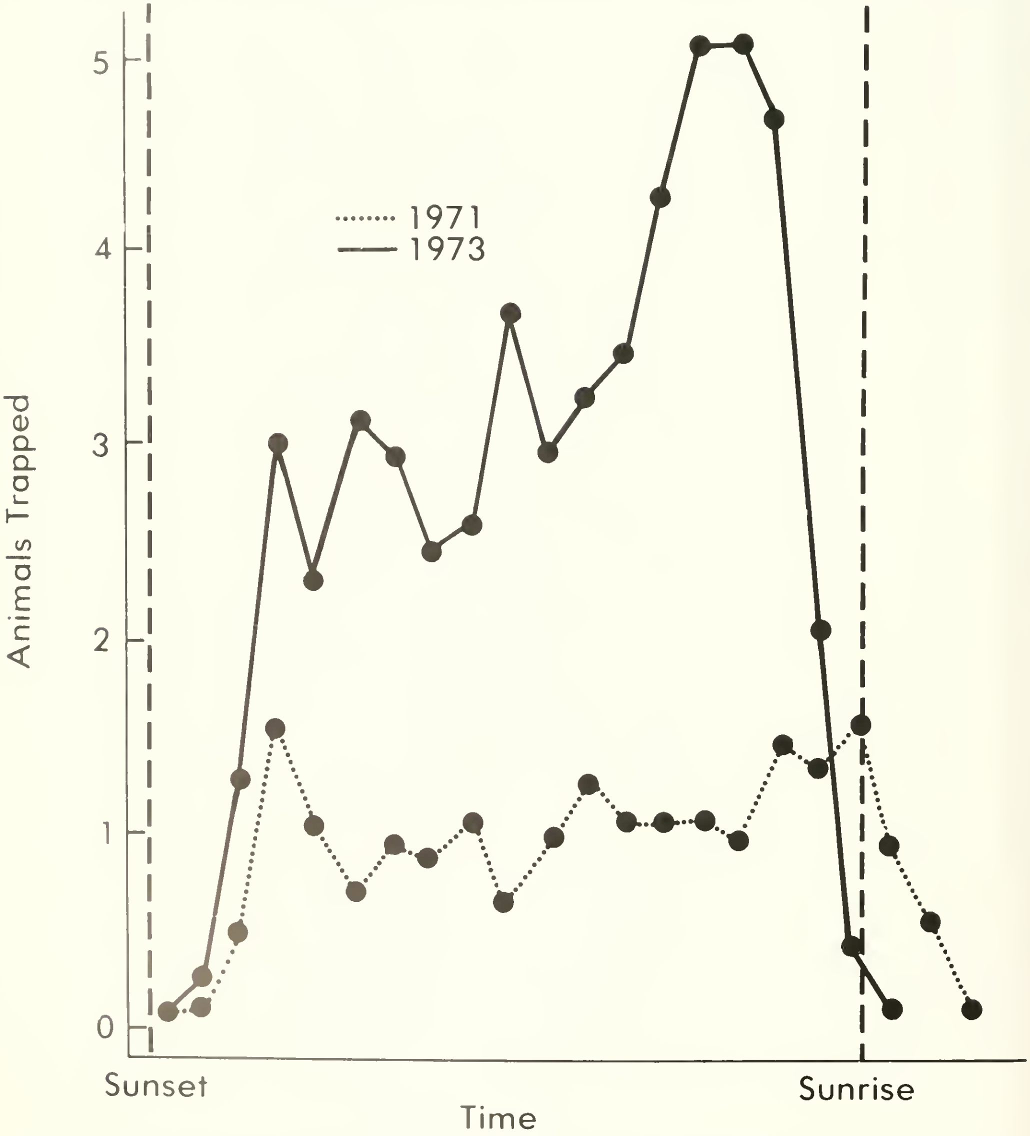

Fig. 2. 1971 and 1973 activity patterns for adult *Dipodomys ordii* pooled among 20 subperiods over a 24-hour activity period.

TABLE 1. Significantly independent ($p = .05$) values of Chi-square tests for *Dipodomys ordii* activity patterns (1971 and 1973).

Variable contrasts	d.f.	X^2
1971 vs. 1973 (all classes combined)	19	131.37
1971 vs. 1973 (males)	19	95.66
1971 vs. 1973 (females)	19	51.41
1971 vs. 1973 (sexually active males)	18	32.48
1971 vs. 1973 (sexually inactive males)	18	68.29
1971 vs. 1973 (all adults)	19	117.41

around a relatively constant level in 1971 to a higher level of activity for more animals in the predawn hours of 1973, a pattern that persisted when all 1973 observations were pooled (Fig. 1).

The activity pattern with all animals still in the population (Fig. 1) was then examined to determine the effects independent variables may have had on it. Schmidt-Nielson (1964) reported that *Dipodomys merriami* was most active at low ambient temperatures, high relative humidity, and high absolute humidity. In 1973, we found that activity increased as temperature decreased and relative humidity increased, a condition that, along with an increase in absolute humidity, occurred most frequently in the predawn hours. *Dipodomys ordii* followed the same activity pattern reported for *D. merriami*, a behavior reported to maximize the conservation of water (Schmidt-Nielson 1964) or accommodate temporal competition with *Dipodomys microps* (Kenagy 1973), where their distributions overlap. This, coupled with increased activity as wind speeds decrease below 3.2 km/hr and after periods of rain, suggests that changes in activity may be related to water conservation.

An additional 40 animals were marked and their activity monitored for five days after 11 dominant animals had been removed from the grid. All except 8 (most of which were trapped near the grid border) of these 40 new animals were juveniles and subadults. The pooled activity pattern shifted to develop a peak in the early evening hours and generally declined thereafter (Fig. 1). Early evening activity exposed the animals to less than optimal conditions for water conservation, but seeds were more abundant on the soil surface because of natural seed-drop and accumulation during the day. Seeds of *Oryzopsis hymenoides* were dropped to the ground in rather large numbers while these data were being gathered. The change in activity may reflect the release from domination, early attempts to reestablish social dominance, or perhaps inexperience among the numerous immature members of the population.

The optimum period of activity aboveground during summer months was during predawn hours when conditions for water conservation were enhanced. Activity patterns of the intact population of *D. ordii* were highest during this predawn period of time. When the social order was disrupted in 1971 due to low rainfall and low vegetative production and in 1973 when the dominant individuals were removed from the population, activity was highest during less optimum conditions for water conservation, but more nearly optimal for seed availability.

Terrell Johnson (1979) found that *Peromyscus maniculatus* is more efficient in harvesting seeds buried up to 0.25 in. in sand when the moisture content of the sand is increased. This observation lends credence to the harvesting strategies demonstrated by the activity pattern of the intact *D. ordii* population, since their peak activity occurred when moisture was highest. Paradoxically, *O. hymenoides* seeds were most abundant in the early evening after they had dropped from the plants during the day. Rodents apparently selected harvesting times that either maximized seed availability or water conservation. From our data, it appears that immature *D. ordii* were most active when seeds were most abundant and adults tended to optimize water conservation.

Since seed-drop is ephemeral and occurs when young animals are most abundant in the population, strategies of *D. ordii* for survival until home ranges can be established seem enhanced by early temporal activity. Annual replacement of older, often nonreproductive adults that have established and control home ranges within the population is important to population survival, since dry years with little or no reproduction are not uncommon. Replacement of the breeding population would facilitate survival of adults during nonproductive years, until reproduction is again feasible. Replacement is likely only if the younger animals obtain a competitive advantage from some source other than size. This might be provided by the "flush" of energy available to preadults that feed during the evening hours when harvest of high quality energy is optimized during years with high seed production. This strategy encourages the infusion of young animals into the population and allows genetic fixation of the activity patterns that optimize the likelihood of survival for *D. ordii* until the next breeding opportunity.

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